Original Article-II

Feasibility, Safety, and Efficacy of the CT Guided Fine Needle Aspiration Cytology (FNAC) of Lung Lesions

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ABSTRACT

Aim: We assessed the safety and accuracy of the CT Guided fine needle aspiration cytology (FNAC) of lung lesions and feasibility of the same as a day care procedure at our hospital.

Methods: We performed a retrospective analysis of case records of patients with lung lesion on plain X ray who underwent CT guided FNAC. Safety was measured in terms of complication rates, efficacy in the terms of sensitivity and specificity; and feasibility in terms of the duration of post procedure hospital stay, total attempts required and the expertise needed to do the procedure. We assumed age, sex and presence of emphysema as patient related variables; size, depth of the lesion and location as the tumour related variables; and type of needle used, experience as the procedure related variables. Medcalc version 7.5 was used for the statistical analysis.

Results: Age, sex, emphysema, radiologist's expertise nor the type of needle changed diagnostic yield. However location of the lesion and size had a significant influence on the diagnostic yield (Accuracy). The complication rates (Safety) were similar irrespective of the patient, tumour related and procedure related variables after adjusting for the potential confounders. It is quite feasible as the average number of attempts needed for final diagnosis is 1.13±0.26 with an average hospital stay of 1.6±0.46 requiring expert hands in less than 35% of instances (feasibility).

Conclusion: FNAC can be used safely as a day care procedure at our setting. The diagnostic yield is excellent for the larger and superficial lesions, for which it can replace the trucut biopsy.

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INTRODUCTION

Transthoracic fine needle aspiration cytology/ biopsy (FNAC) is a well established and safe technique in evaluating the pulmonary lesions.[1] Menetrier was the first to use this method in diagnosis of lu 54ng carcinoma.[2] This method had evolved through fluoroscopy, ultrasonographic guided to the CT guided procedure and Haaga and Alfidi reported the first CT-guided biopsy in 1976.[3] Since then multiple studies have evaluated the diagnostic accuracy, complication rate and an overall feasibility of this procedure and found it to be safe and effective.[4-18] The diagnostic sensitivity

of transthoracic FNAC for malignant lesions ranges from 76% to 97%.[4-7,9-18] The complication rates of this procedure ranges from 5% to 61%, with a mean of 20%.[4-18] While diagnostic sensitivity has been higher for fluoroscopy guidance (97%) than CT guidance (80%), there is a higher rate of complications for FNAC in the former procedure.[9,18] The present study was performed to determine the accuracy and complications of CT-guided FNAC at our center.

METHODS

Between January 2001 and December 2004, the case records were evaluated. Patients presenting with lung lesion on plain X ray were subjected to the CT guided FNAC. Before performing a CT guided FNAC, a routine CT scan was done and the baseline tumour characteristics were evaluated based on the same. Data was collected from those where institutional protocol was followed uniformly for the pre procedure instigations to determine the fitness for the procedure. All such eligible patients underwent FNAC as per the standard guidelines after obtaining an informed consent. A total 236 patients were included for analysis where final histopathology report was available for confirmation.

Procedure: For CT guided FNAC, 18 /22 G Chiba needles was used. Skin entry point was marked with skin marker and local anesthesia was given with 2% lidocaine. The same needle was left for reference and a single axial scan was obtained; this was subsequently exchanged with the biopsy needle. Needle tip position was confirmed with additional scans and cytology was obtained. After the biopsy, the patients were positioned for 30 minutes in a recumbent position. An expiratory chest radiograph was then obtained. If no pneumothorax was detected patients were allowed to return home. If a small (<30%) pneumothorax was detected, patients were repositioned and an additional radiograph was obtained after 2 hours; if the pneumothorax was stable, patients were allowed to go home and return the next day for a control chest x-ray. In case of large (30% or more), enlarging or symptomatic pneumothorax, chest tube was immediately inserted; symptomatic outpatients were hospitalized overnight in case of severe distress.

Cytopathologists were present on site during the procedure. Repeat FNAC was done immediately in cases of diagnostic dilemma. Final diagnosis was proven by biopsy specimens. Clinical details like age, sex, presence of emphysema at presentation and the exact pathological and radiological details were noted down. Wherever the data was inadequate, they were excluded from the analysis. Stratification was done for each variable as below.

- **Patient related:** Gender (male, female), Age (<65, > 65 years), Presence or absence of emphysema
- **Tumour related:** Size (<20mm vs. >20 mm), Site from skin surface (superficial- < 5 cm vs. deep- >5cm), location based on lobe
- **Procedure related:** Expertise (those who are doing at least 8 procedures per week for more than 2 years vs. those who have less expertise) and thin needle(22 G) vs. wide boar needle (>18 G)

Statistical analysis: The stratified groups were then compared with respect to patient demographics, lesion charac-teristics, biopsy technique–related variables, complications, diagnostic yield, and accuracy. We also evaluated the effects of lesion size, depth, size of the needle, expertise on the diagnostic yield and the complication rates. The significance calculated from the mean of a continuous variable was analyzed by using two-tailed *t* tests, and the categorized variables were analyzed by using Pearson x^2 tests. $P < .05$ was considered to indicate statistical significance. ROC curves generated to predict the cut off

value for maximum diagnostic accuracy for the tumour related variables viz. size and depth.

RESULTS

236 patients eligible for the study, 36 were excluded because of incomplete details. Final analysis was done for the 200 patients. Out of all patients 20 patients had significant COPD (All cases had emphysema requiring regular treatment). However in view of good performance status and need for diagnosis, all have undergone CT guided FNAC.

The base line parameters are shown in table 1. Males dominated over females with M: F ratio of 1.8:1 and there is no significant difference in the various patient and tumour related parameters in both groups.

Majority of the patients had carcinoma lung as primary diagnosis followed by metastatic lesions (adeno carcinoma and poorly differentiated carcinoma with a prior history of malignancy). The exact details of various histological subtypes are shown in the table-2.

Details of the depth and size of lesions using different needle thickness are shown in the table 3. There was no significant difference between the thin and thick needles.

Diagnostic accuracy was calculated based on the final histopathology report and comparing it with FNAC. Diagnostic accuracy for various variables was calculated and the results are shown in the table 4.

We observed that there was a significant fall in the accuracy once the lesions are smaller than 2 cm or the distance traversed by the needle is more than 5 cm. Based on these observations, ROC curves have been generated to check for the best possible size of the lesion having maximum sensitivity & specificity. We found that CT guided aspiration had reasonably good sensitivity and specificity at any size > 2cm (figure1). The results for the depth of the

Table1: Baseline Patients Characteristics

Variable	Male (n=129)	Female(n=71)	p
Age (years)	48.5±16.2	42.5±13.2	NS
Performance status (WHO) 0,1 ≥2	 64% 36%	 66% 34%	 NS
Mean depth of tumour (calculated by CT scan) in cm.	3.8±2.6	4.2±2.8	NS
Mean size of tumours (calculated by CT scan) in cm.	2.8±1.4	3.1±1.6	NS
Persons performing Procedure Expert Trainee	 45% 55%	 42% 58%	 NS
Tumour location Upper lobe Middle lobe Lowe lobe	 25% 35% 40%	 20% 42% 38%	NS NS

Table 2: Histological diagnosis

Diagnosis	Number of patients
Carcinoma Lung (non small cell)	76 (38%)
Carcinoma Lung (small cell)	34 (17%)
Metastatic Adenocarcinomas	45 (23%)
Poorly differentiated Carcinoma	15 (8%)
Lymphoma	28 (14%)
Benign lesions	2 (1%)

Table 3: Mean depth and size of the lesions with thin and thick needles.

	Size (in Cm)	Depth (in Cm)
Thin needle (95)	3.1±1.4	4.2±2.2
Thick needle (105)	2.7±1.2	3.9±2.1
Value	NS	

lesion indicate that the sensitivity & specificity will fall significantly if the lesions are located > 5cms deep (figure 2). However the expertise did not matter so as the thickness of the needle, or the tumour location.

The rate of various complications in different groups are shown in table 5.

We also tried to assess the complication rates based on the number of punctures, age of patient and distance traversed by the needle. The results are represented in the table-6. Our findings suggest that patients with increasing age, number of punctures and the distance traversed the complication rates increased proportionately and inverse relation was observed with the tumour size and co-morbid condition.

DISCUSSION

The ultimate aim of any image guided histological or cytological study is to avoid unnecessary thoracotomy, and achieve a definite diagnosis with reasonable accuracy and minimum side effects. Multiple studies have been conducting for evaluating the accuracy and safety of CT guided percutaneous needle aspiration biopsy of the lung comparing the results in various sizes of lung lesions.[1-14] The results suggested that it is feasible with

Table 4: Diagnostic accuracy for various tumour and procedure related variables

Number of punctures	**Accuracy**
One	82%
Two	86%
Three	92%
Distance of needle traversed (Cm)	
<1	95%
1-2	93%
2-3	88%
3-4	78%
4-5*	60%
5-6*	48%
6-7*	39%
>7*	26%
Thickness of needle	
Thin needle (20-22G)	86%
Thick needle (16-18G)	94%
Expertise	
Trainee	82%
Expert	96%
Lesion size (cm)	
<1 **	56%
1-1.5**	68%
1.5-2**	78%
2-2.5	92%
2.5-3	94%
>3	96%
Lobe	
Upper	68%
Middle	82%
Lower	94%

*Significantly different from needle path length ≤ 5 cm *($P < 0.05$)*

**Significantly different from lesion sizes ≤ 2 cm *($P < 0.05$)*

Table 5: Spectrum of complications in each group of patients

Complication	Pneumothorax (Minor) (%) N=60 (30)	Major` pneumothorax requiring ICD N=10 (5)	Hemorrhage N=12 (6)	Infection* N=8 (4)
Age <65	48/150 (32%)	6/150(4%)	6/150(4%)	3/150(2%)
>65	12/50 (24%)	4/50(8%)	6/50 (12%)	5/50 (10%)
P value	NS	NS	0.05	0.05
Co morbidity +	6/20 (30%)	2/20 (10%)	4/20 (20%)	2/20 (10%)
NO co morbid	54/180 (30%)	8/180 (4%)	8/180 (4%)	6/180 (3%)
P value	NS	NS	0.04	0.06
Depth <5 cm	24/120 (20%)	4/120 (3%)	4/120 (3%)	4/120 (3%)
< 5 cm	36/80 (45%)	6/80 (7.5%)	8/80 (10%)	4/80 (5%)
P value	P=0.03	NS	0.06	NS
Lesion <2 cm	20/60 (33%)	3/60 (5%)	5/60 (8%)	3/60 (5%)
<2 cm	40/140 (29%)	7/140 (5%)	7/140 (5%)	5/140 (4%)
P value	NS	NS	NS	NS
Expert	16/82 (19%)	4/82 (5%)	4/82 (5%)	4/82 (5%)
Trainee	44/ 118 (37%)	6/118 (5%)	8/118 (7%)	4/118 (4%)
P value	P=0.04	NS	NS	NS
Thin needle	20/95 (21%)	5/95 (5%)	6/95 (6%)	4/95 (4%)
Thick needle	40/105 (38%)	5/105 (5%)	6/105 (6%)	4/105 (4%)
P value	P=0.04	NS	NS	NS

*Infections defined as fever with cough and features of pneumonia either radiological or clinical. All the patients have complete resolution of the same following appropriate antibiotic therapy without any sequels.

reasonable good accuracy. Various factors influence the diagnostic yield like tumour size, location, thickness of the needle, location of tumour, presence of emphysema and more recently, the angle of insertion of the needle. The complication rates are highly variable ranging as low as 15% to as high as 68% depending on the presence of risk factors.[4-12,15-18] In our study, the rate of pneumothorax was 30%, and that of chest tube placement was 5%, which were similar to rates observed in other studies.[4-12,15-18,20-26] Among the numerous reports investigating factors that influence the complication rates, many have yielded ambiguous results.[4-12,15-18] because of various

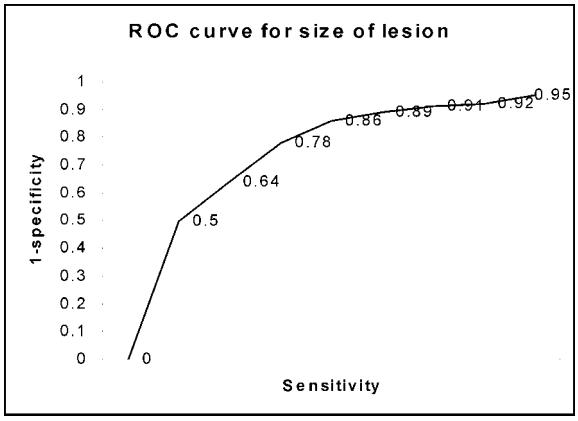

Figure1: ROC curve drawn for sensitivity and 1-specificty for size of lesions starting from 0.5 cm at 0.5cm increments.

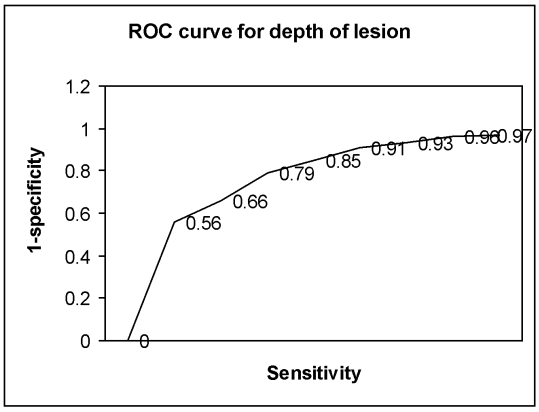

Figure2: ROC curve drawn for sensitivity and 1-specificty of depth of lesions starting from 1 cm at 1 cm increments.

technical means and inappropriate methods of statistical analysis. Moreover, these results were based on a limited number of patients. The present study evaluates the risk of complications in patients undergoing CT-guided FNAC, and the accuracy of the procedure. Based on the available literature, complication and accuracy were influenced by patient factors (age, sex, lung function, and presence of emphysema), lesion variables (size, depth, location, and pleural contact), and procedure-related factors (experience of the

Table 6: Rate of overall complications for Each Range of Influencing Factors

Number of punctures	**Complication rate**
One	8%
Two	18%
Three	48 %
Distance of needle traversed (Cm)	
<1	**7%**
1-2	**13%**
2-3	**18%**
3-4	**22%**
4-5	**26%**
5-6	**38%**
6-7	**46%**
>7	**59%**
Age of the patients	
<30	**18%**
30-45	**25%**
45-60	**36%**
60-80	**49%**

operator, degree of difficulty, imaging method used for guidance, and type of needle used).[4-28]

PATIENT CHARACTERISTICS: We did not find an increased complication rates in elderly and patients with pre-existing emphysema. However other complications like infection and bleeding were higher in the above said population. Therefore under proper antibiotic coverage both elderly and pre existing (co-morbid lung conditions) COPD patients can be taken for the CT guided FNAC without increased risk. The gender differences influencing the yield and complication rates are variable.[6-11,16-19, 22-26] The present study refutes any gender differences in complication rates or the diagnostic yield.

PROCEDURE/ TECHNIQUE RELATED

Needle thick ness, angle and its influence on the complication rate and diagnostic yield-

Although fine needles (20–22 gauge) are adequate in most cases,[20-23] some authors prefer larger needles. Some suggest that larger needles have no higher complication rates than fine needles, however the results are conflicting.[16,18, 20-25] Our study suggests that the minor complication rates (minimal pnemothorax) were higher with thick needles and there is no difference in the diagnostic yield irrespective of the thickness of the needle. In view of only a small increment in the minor complication, we opine that the practicing radiologists can use the thickness with which they are comfortable without any major changes in either diagnostic yield or complication rates. As in previous studies, we also observed that the number of needle passes was important and as the number of entries cross the magical number 3 we had much higher complication rates and we do not suggest more than two attempts barring the few exceptional circumstances. Few authors have noticed less success with greater angulations in hitting the nodules by a single insertion, and have concluded that the angulation might have some correlation with the number of attempts. They emphasize that the angle of the needle path is a novel predictor of pneumothorax after CT-guided lung biopsy. However we did not look into this particular variable in the present study.

Expertise: Our findings suggest that though the accuracy appeared to be more in expert hands than trainees, it did not reach statistical significance probably owing to small sample size. Though minor pneumothorax rates are higher in the trainee's hands, there is no difference in the major complication rates. The results contradict the popular notion[8,9] that complication rates are less in expert's hands; rather they were influenced by the tumour location and size.

TUMOUR RELATED FACTORS:

Tumour location and its influence on the complication rate and diagnostic yield: Deeper lesions have more complication rates and fewer yields compared to the superficial lesions. A long pleura-to-lesion distance is a major predictive factor of pneumothorax following CT-guided lung biopsy in this present study, so as less diagnostic yield, which agrees with multivariate studies. The cut off value for our institute was 5 cm which is well in agreement of 3.5-6.0 cm observed by various authors.[4-12,18-25,27-29]

Tumour size and its influence on the complication rate and diagnostic yield: According to current reports of CT screening for early lung cancer, the detection of small lung cancers may improve the prognosis of lung cancer patients.[8] How to manage patients with growing solitary pulmonary nodules that are 20 mm or smaller is the ultimate question for radiologists and clinicians. The overall diagnostic accuracy (56-78%), pneumo-thorax rate (33%), and chest tube insertion rate (5%) of CT-guided trans thoracic needle aspiration

biopsy of small solitary pulmonary nodules observed in the present study were within the ranges of results of CT-guided biopsy reported in the literature, which include any size of solitary pulmonary nodule.[8,12,24-26] Therefore small lesion per se is not a contraindication for performing the FNAC. The results of the present study for the malignant pulmonary neoplasm confirm that these lesions can be diagnosed at centers with minimal expertise. The only factors affecting the diagnostic yield are size of the lesion less than 2cm & deep seated lesions located more than 5cm deep.

Conclusion: The present study confirms that FNAC can be used safely as a day care procedure. The diagnostic yield is excellent for the larger and superficial lesions, for which it can replace the trucut biopsy. It scientifically disproves few common myths associated with CT guided FNAC.

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